

FIG. 5.—Average date of the first leafing of the soft maple in Missouri. (Four years, 1904-1907, observations).

observations which are calculated to develop the seasonal temperature fluctuations in the layers of the atmosphere and the earth which are nearest each other. One may observe that the thermograms of the average maximum and average minimum temperatures clearly indicate that for Mexico, Mo., the coldest day of winter is February 4. Immediately after that date both curves begin their ascent, indicating that the layers of earth and air in contact begin to receive more heat than they lose by radiation. Each successive drop in the minimum curve, occurring every four to six days, is a little weaker than the preceding one, for spring is approaching.

Is it possible for vegetal and insect life to awaken while the average daily minimum temperature remains below 32° F.? One may often experience a warm, spring-like day during the latter part of February and the first of March, but no insect seems to be stirring. Now we find that the curve of the average minimum first rises above 32° on March 10 (see fig. 1), but the writer does not believe that may be properly called the opening day of spring, for the curve continues below the freezing temperature line for a whole week longer. On the 18th, however, it finally rises and remains above the 32° line, and this date is evidently the opening day of spring, when that "first mysterious touch of Nature" takes place. While March 18 may mark the awakening, there is very little to indicate the phenomenon at this time, as all life seems yet dormant; but "the sap begins to run," and some time between April 8 and 12 the soft maple, which is an early variety, begins to put forth its first leaves. The progress across Missouri of this spring awakening of the soft maple is strikingly and clearly shown by the date lines of fig. 5.

The spring weather of Mexico, Mo., its many variations from warm to cool, sunshine to showers, is interestingly shown by fig. 2, which also shows the increasing stability of the weather as summer approaches. We have taken June 2 as the first day of summer because that is the first day on which the mean daily temperature reaches 70° and remains above it.

The astronomer informs us that the longest day of the northern [astronomical] summer is June 21, when the sun rises farthest in the north and sets farthest in the north. But it is generally known that the greatest heat of summer does not occur until some time after this date. The flood time of summer has never been, heretofore, definitely pointed out. Some observers have gone so far as to say that summer begins to wane in July, but this can not be true of Mexico, Mo., nor indeed of the central and greater portion of the United States. Summer can not wane before the maximum heat has been attained. About fifty days after the summer solstice, or the longest day of the northern year, i. e., about August 8 or 9, we

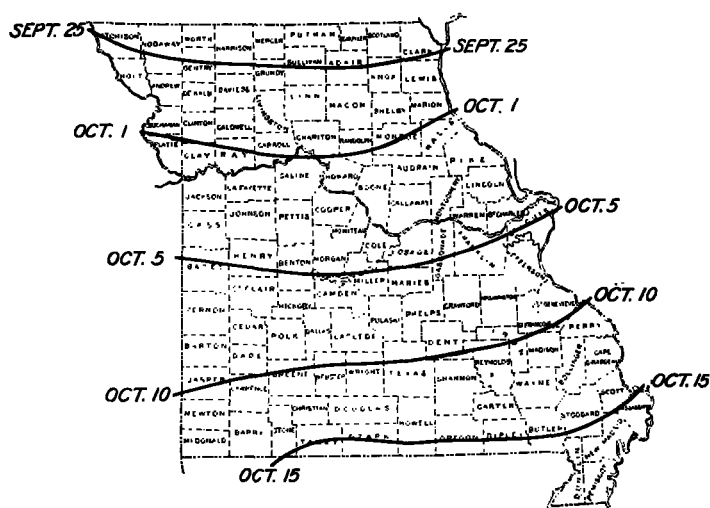


FIG. 6.—Average date on which the forests begin to assume autumn colors in Missouri. (Four years' observations).

reach the flood time of summer. The full flood of summer may be said to continue from July 15 to August 9, but it appears from fig. 3 that the maximum heat is attained on August 9 at Mexico, Mo. This figure shows clearly the steadily high temperatures from about July 15 to August 9, and that almost immediately following the latter date the ebb begins.

Both the maximum and the minimum thermograms, but more particularly the minimum, show clearly how the earth now begins to lose more heat by radiation than it received during the day. At each successive change the temperature curve drops a little lower than at the preceding change; the changes take place slowly for the first fifteen or twenty days, then the magnitude of the successive drops increases very noticeably. We plainly see "the signs of a dying year." And thus we approach the opening day of autumn, which I put at or about September 12 for the locality under discussion. Some fifteen or twenty days later we see the forests beginning to assume their autumn colors. As fig. 6 shows, this change is first noticed in the northern part of the State about September 20 and, reversing the direction of the march of the first leafing shown in fig. 5, sweeps slowly southward across the whole State, occupying about a month in its passage.

Our minimum thermogram, fig. 4, shows that winter begins at Mexico, Mo., on November 23, when the average daily minimum falls below 32° and stays there. Quite a month later the days are the shortest and the hours of darkness are the longest, but the winter cold does not reach its minimum until February 4, or about forty-five days after the winter solstice.

The curve of the average minimum temperatures shows that spring, as here defined, is made up of 77 days, summer of 101 days, autumn of 72 days, and winter of 115 days.

The total precipitation for the thirty years, 1878-1907, is shown day by day in figs. 1 to 4, which bring out clearly the rainfall of the different periods, the increase from winter to spring and summer, and the decrease to autumn again. The days of the years which have the heaviest rainfalls or are most frequently rainy are readily picked out since they have the tallest columns, i. e., have the greatest totals for the whole thirty years.

ICE CONDITIONS ON THE GREAT LAKES, WINTER OF 1908-09.¹

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On account of the comparatively mild winter in the Lake region there was less ice reported in all of the lakes. The

¹Similar details as to ice in the Great Lakes for the winters of 1899-1907 will be found in the Lake Charts for those years, published semiannually by the Weather Bureau, also in Monthly Weather Review, August, 1908, 36:239-244, and May, 1908, 36:137-140.

thickness was not as great as the previous season. In Superior the fields apparently shifted freely with the winds and more extensive fields appeared over the eastern portion during the latter part of March. In Michigan the main fields were confined to the extreme northeastern portion from the islands northeast to the straits. During about ten days in March there was a small field over the extreme southeast portion of the lake. At the straits the ice attained a thickness of 20 inches, which is 2 inches thicker than last winter, but it was not windrowed. While vessels forced a passage through the ice on April 14, 1909, the ice did not disappear until April 28, 1909. In Huron there were no heavy or extensive fields reported during the winter. Over the extreme southern portion the field was intact for only about ten days in March. The ice did not impede navigation and there was not a heavy run into the St. Clair River. The ice in Lake St. Clair was not heavy

at any time during the winter and was broken up and ran out early in March. Over the western portions of Erie, except around the islands, the ice disappeared early in March. The shifting winds moved the ice fields, so that there appeared more extensive fields over the eastern portion during the last two weeks of March than occurred during the previous season. These fields were not heavy and were easily broken up. As is usual, on account of prevailing southwest winds, the field was driven to the extreme eastern portion of the lake, gradually disappearing. The last ice was reported at Buffalo on April 28, 1909. The disappearance of ice this year was about eleven days earlier than of the season of 1908. The fields in Ontario were not heavy. They disappeared over the western portion early in March, and over the extreme eastern portion the ice was reported as late as April 7, 1909.

TABLE 1.—The closing and opening of navigation, and the ice conditions on the Great Lakes during the winter of 1908-9.
LAKE SUPERIOR.

Stations.	Navigation.		Ice first formed.	Greatest thickness.	Ice disappeared.	Remarks.
	Closed.	Opened.				
Duluth, Minn.	Dec. 10, 1908	1909. Apr. 11	Dec. 1, 1908	Inches. 29.0	1909. Apr. 7	Local navigation closed January 16, 1909. There was a considerable field of ice along the south shore after it had disappeared in Duluth Harbor.
Allouez, Wis.	Dec. 8, 1908	Apr. 22	Dec. 1, 1908	20.0	Apr. 23	
Two Harbors, Minn.	Nov. 28, 1908	Apr. 11	Dec. 1, 1908	4.0	Mar. 23	Fish tugs kept the harbor open and made trips between this port and Grand Marais, Ont., until February 2, 1909.
Bayfield, Wis.	Jan. 1, 1909	Apr. 23	Jan. 10, 1909	30.0	May 7	Ice became impassable for teams about April 10, 1909.
Washburn, Wis.						Ice began breaking up about April 13, 1909.
Ashland, Wis.	Dec. 5, 1908	Apr. 24	Dec. 5, 1908	27.0	May 7	The steamer <i>Charles G. Jenkins</i> broke her way into the harbor on April 23 and 24, 1909.
Ontonagon, Mich.	Dec. 6, 1908		Nov. 1, 1908	23.0		Harbor not closed by ice until January 25, 1909.
Ship Canal, Mich.	Dec. 9, 1908	May 4	Nov. 23, 1908	12.0	Apr. 15	But a small amount of broken ice in the canal and harbor after April 13, 1909.
Eagle Harbor, Mich.	Dec. 17, 1908	Mar. 30	Jan. 15, 1909	14.0		
Houghton, Mich.	Dec. 7, 1908	May 4	Dec. 3, 1908	17.0	May 10	Navigation opened through the lower entry (Big Portage) on May 6, 1909.
Marquette, Mich.	Dec. 5, 1908	Apr. 21	Jan. 1, 1909	10.5	Apr. 20	The ice field extended beyond vision on March 9, and remained practically unchanged until about April 10, 1909.
Grand Marais, Mich.	Dec. 12, 1908		Nov. 30, 1908	28.0	May 5	Harbor ice broken up and moving out April 13 and Lake Superior practically clear of ice off this port on same date.
Whitefish Point, Mich.	Dec. 15, 1908					Whitefish Bay froze over February 12, 1909, and remained solid until about April 6. The eastern end of the bay and the lake off this port practically clear of ice on April 11, but ice fields drifted in after this date.
Sault Sainte Marie, Mich.	Dec. 13, 1908	Apr. 20	Dec. 4, 1908	19.0		Harbor ice broke and running except behind canal piers on April 8, but upper end of river still solid; the St. Marys River began breaking up about April 13, and a passage was forced on April 20. The first up bound passage through the American lock was steamer <i>G. W. French</i> at 7:30 p. m. April 20, and through the Canadian lock was steamer <i>Paliki</i> at 7:05 a. m. April 21. The first down bound through the American lock was steamer <i>Northern Queen</i> at 4:38 p. m. April 26, and through the Canadian lock was steamer <i>Carleton</i> at 5:10 p. m. on same date.

LAKE MICHIGAN.

Gladstone, Mich.	Dec. 5, 1908	Apr. 19	Dec. 3, 1908	21.0		Ice covered with about 10 inches of snow most of season.
Escanaba, Mich.	Dec. 20, 1908	Apr. 19	Dec. 22, 1908	25.0		Considerable ice remained in the upper bay when navigation opened.
Menominee, Mich.	Jan. 2, 1909	Apr. 23	Dec. 1, 1908	17.5		The tug <i>Satisfaction</i> reached Menominee from the east shore at noon April 22, after a hard fight with floating ice.
Green Bay, Wis.	Dec. 7, 1908	Apr. 14	Dec. 2, 1908	12.0	Apr. 24	The river began breaking on April 20, 1909. The ice on Green Bay was broken up by northwest gale on April 7, but did not move out at that time.
Sturgeon Bay, Wis.	Jan. 1, 1909	Mar. 28	Dec. 2, 1908	18.0	Apr. 24	Navigation through to Green Bay closed December 15, 1908, and the car ferry <i>Ann Arbor No. 3</i> broke her way through the ice en route from Menominee to Ludington on April 14, 1909.
Kewaunee, Wis.			Nov. 20, 1908	3.0		Navigation has remained open throughout the winter; but two or three inches of ice formed at any time would be broken up by steamers making this port, and would then drift out into the lake.
Manitowoc, Wis.			Nov. 14, 1908	15.0	Mar. 30	Navigation has remained open throughout the winter; and what ice formed in the harbor was broken up by the car ferries and it soon drifted out into the lake. The ice in the river above the Wisconsin Central Railway slip formed to a thickness of 15 inches.
Sheboygan, Wis.	Dec. 19, 1908		Jan. 5, 1909	3.5		Practically no ice in the harbor as fish tugs have kept it open. Ice fields were drifted in and out of the bay by the wind.
Milwaukee, Wis.	(Dec. 16, 1908)					Several lines of steamers make this port regularly throughout the year but general navigation (interlake) closed about December 16, 1908. Very little ice formed inside the breakwater but the harbor was filled with slush ice, which drifted in and out with the wind, from February 14 to 24 and from March 16 to 21.
Racine, Wis.						This port open for navigation throughout the year.
Kenosha, Wis.						This port open for navigation throughout the year.
Chicago, Ill.						This port open for navigation throughout the year. Floating ice has been very constant during the winter although seldom in great quantity. During the northeast gale of February 18 and 19 floating fields of considerable size were observed and smaller fields were constant until March 2.
Michigan City, Ind.	(Dec. 15, 1908)		Dec. 5, 1908	8.0	Mar. 9	General navigation closed about December 15, 1908 but the harbor has been practically clear of ice except when field ice was drifted in from the lake.
St. Joseph, Mich.	(Dec. 18, 1908)		Jan. 1, 1909	6.0		The harbor has been open practically all winter except when closed by drifting fields of ice from the lake.
South Haven, Mich.	Jan. 1, 1909	Mar. 9	Dec. 31, 1908	4.0	Mar. 30	There has been but little ice in the harbor during the winter and but few ice fields have been observed in the lake.
Holland L. S. S., Mich.	Dec. 24, 1908	Mar. 9	Jan. 1, 1909	5.0	Mar. 25	Few ice fields have been observed off this port.
Grand Haven, Mich.			Jan. 11, 1909	2.0		Navigation remained open all winter at this port and during the past winter it has been impeded but slightly by ice.
Muskegon, Mich.				8.0	Mar. 14	The harbor has been open most of the winter. Ice in Muskegon Lake formed to about 5 inches.
Pentwater, Mich.	(Dec. 31, 1908)		Jan. 7, 1909	12.0	Apr. 13	Fish tugs continued to operate until January 8, 1909. But little field ice has been observed off this port during the past winter.
Ludington, Mich.		(Mar. 9)	Dec. 10, 1908	11.0		The harbor was partially frozen over but navigation has been open all winter. Fish tugs began operations March 9, 1909.
Manistee, Mich.	Dec. 13, 1908	Mar. 27	Dec. 9, 1908	14.0	Apr. 6	The maximum thickness of ice in the harbor was about 8 inches.
Frankfort, Mich.			Dec. 4, 1908	14.0		The car ferries have kept this harbor open all winter.
Glen Haven, Mich.	Dec. 7, 1908	Mar. 27				There has been practically no ice off this port during the past winter.
South Manitou, Mich.						There has been but little ice on the beach. This port has been open to the mail and fish boats all winter.
Harbor Springs, Mich.	Dec. 14, 1908	Apr. 15	Jan. 1, 1909	15.0	Apr. 20	A field of ice about 7 miles wide lay off this port during most of March, 1909.
St. James, Beaver Island, Mich.	Jan. 15, 1909 ^a	Mar. 28 ^b		15.0	Mar. 29	
Mackinaw, Mich.	Dec. 13, 1908 ^c	Apr. 14 ^c	Dec. 2, 1908	20.0	Apr. 28	Much less ice than usual in the Lake Michigan entrance to the "Straits".

^a Last departure. ^b First arrival. ^c First departure.

LAKE HURON.

Stations.	Navigation.		Ice first formed.	Greatest thickness.	Ice disappeared.	Remarks.
	Closed.	Opened.				
Mackinac Island, Mich.....	Dec. 13, 1908	1909. Apr. 14	Dec. 27, 1908	Inches. 14.0	1909. Apr. 28	Navigation between the island and mainland did not close until February 11, 1909 and the mail steamer reached the dock from St. Ignace on April 2, 1909.
Detour, Mich.	Dec. 20, 1908	Apr. 19	Dec. 16, 1908	10.0	.....	Four steamers reported stuck in the ice between Sweets Point and Lime Island. The ice in St. Marys River forced April 20, 1909.
Cheboygan, Mich.....	Dec. 23, 1908	Apr. 14	Jan. 12, 1909	8.0	Apr. 13	Fish tugs operated until January 3, 1909. Harbor free of ice on April 6, 1909 and no ice south of the light-house.
Presque Isle, Mich.....	Dec. 15, 1908	Apr. 14	Dec. 1, 1908	29.0	Apr. 10	Harbor full of broken ice and many ice fields, drifting with the wind, off this port during March 1909.
Middle Island, Mich.....	Dec. 15, 1908	Apr. 14	Dec. 2, 1908	5.0	Mar. 30	Ice fields not as extensive as former winters and the ice was not so thick. A few floating pieces of ice visible April 13, 1909, in the lake.
Thunder Bay Island, Mich. ..	Dec. 13, 1908	Apr. 14	Dec. 2, 1908	6.0	Mar. 23	Very little ice has formed around this island as compared with former years.
Alpena, Mich.....	Dec. 8, 1908	Mar. 28	Dec. 12, 1908	12.0	Mar. 23	Fish tugs began setting their nets March 11, 1909. Thunder Bay clear of ice March 23, 1909.
Oscoda, Mich.....	Nov. 28, 1908	.....	.....	.....	.....	Only few fields of ice observed off this port during the past winter and they have not been of sufficient thickness to obstruct the movements of fish tugs.
Tawas Point L. S. S., (East Tawas), Mich.	Dec. 12, 1908	.....	Nov. 15, 1908	13.0	Apr. 13	Ice formed over the bay during the early part of the winter but was broken up and driven out by northeast gale on January 29, 1909.
Bay City, Mich.....	Dec. 5, 1908	Apr. 13	Dec. 3, 1908	12.0	Apr. 6	Saginaw River clear of ice March 30, 1909. Tug <i>Arthur Jones</i> cleared for Buffalo on April 18, 1909.
Point aux Barques, Mich.....	Dec. 9, 1908	.....	Jan. 6, 1909	10.0	Apr. 6	Ice field did not exceed 3 miles in width during the past winter.
Harbor Beach, Mich.....	Dec. 11, 1908	.....	Dec. 1, 1908	8.0	Mar. 30	But few fields of ice visible off this port as compared with former years.
Port Huron, Mich.....	Dec. 16, 1908	Mar. 29	Dec. 5, 1908	10.5 ^a	Mar. 26	A large field of ice was observed at the mouth of the lake March 23, 1909 but most of it was blown back up the lake and did not pass down the river.

^a Measured in Black River.

DETROIT RIVER.

Detroit, Mich.....	Dec. 14, 1908	Mar. 29	Dec. 8, 1908	8.0	Mar. 23	The ice in Lake St. Clair was broken up by warm wave January 25, 1909. Heavy snow and some slush ice retarded the ferries somewhat on February 16 and 17, 1909. On March 7 the steamer <i>Pleasure</i> made a trip to Bois Blanc and reported no ice encountered. A channel from Lake St. Clair to Lake Erie was open on March 15, 1909. Navigation was opened by the steamer <i>City of Detroit</i> on March 29, to Cleveland, and the steamer <i>W. J. Carter</i> passed down same day.
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LAKE ERIE.

Toledo, Ohio.....	Dec. 14, 1908	Dec. 9, 1908	5.5	Mar. 9	Maumee River cleared of ice February 24, 1909; very little ice in Maumee Bay after this date.
Put-in-Bay, Ohio.....	Jan. 1, 1909	Mar. 23	Jan. 15, 1909	6.0	Mar. 27	The ice around the islands was broken up on March 16 and a steamer could have easily reached the landings by March 23, 1909.
Kelleys Island, Ohio.....	Dec. 31, 1908	Mar. 10	Dec. 20, 1908	8.0	Mar. 27	Ice fields off this port were not as heavy as usual.
Marblehead, Ohio.....	Dec. 15, 1908	Mar. 10	Jan. 1, 1909?	4.0	Mar. 23	Harbor practically clear of ice March 2, and no ice observed in the lake after March 16, 1909.
Sandusky, Ohio.....	Dec. 28, 1908	Mar. 10	Dec. 8, 1908	5.0	Mar. 23	Sandusky Bay was clear of ice on March 8, 1909.
Huron, Ohio.....	Dec. 11, 1908	.....	Dec. 10, 1908	5.0	Mar. 16	No ice in the lake off this port after March 16, 1909.
Lorain, Ohio.....	Dec. 10, 1908	.....	Jan. 12, 1909	3.0	Mar. 9	No ice in the lake off this port after March 23, 1909.
Cleveland, Ohio.....	Dec. 11, 1908	Mar. 29	Jan. 2, 1909	4.0	Mar. 26	This port was practically open for navigation except for two weeks in the latter part of March when northerly winds drove a heavy field into the harbor. Fishing tugs were operating with very little difficulty on March 30, 1909.
Ashtabula, Harbor, Ohio.....	Jan. - 1909	Mar. 30	.....	7.0	Mar. 30	A large ice field driven in by the wind, prevailed off this port for about two weeks during the latter part of March.
Conneaut Harbor, Ohio.....	Feb. 5, 1909	Mar. 8	Jan. 1, 1909	.....	Apr. 2	The ice fields off this port were not as extensive nor as thick as usual.
Erie, Pa.	Dec. 19, 1908	Apr. 1	Nov. 4, 1908	4.5	Apr. 6	Navigation closed by departure of the steamer <i>Davidson</i> on December 23, 1908. There was no ice in the harbor after April 9. The ice in this end of the lake was broken up by the gale of April 7 and gradually passed down the river until April 26, 1909.
Dunkirk, N. Y.....	Dec. 31, 1908	.....	Dec. 23, 1908	4.5	Apr. 13	.....
Buffalo, N. Y.....	Dec. 28, 1908	Apr. 16	Dec. 23, 1908	6.0	Apr. 26	.....

LAKE ONTARIO.

Fort Niagara, N. Y.....	Dec. 6, 1908	.....	Dec. 23, 1908	6.0	Apr. 27	No ice in this vicinity on March 30, but considerable came down the Niagara River after this date and the river was blocked on April 13, 1909.
Charlotte, N. Y.....	Dec. 3, 1908	(Mar. 9?)	Jan. 7, 1909	4.0	Mar. 9	All ice cleared from the harbor on the afternoon of March 25 and none visible in the lake after March 9, 1909.
Sodus Point, N. Y.....	Dec. 9, 1908	Mar. 25	Dec. 9, 1908	12.0	Mar. 25	Some ice remained in the coves, but there was no ice visible in the lake after March 2, 1909.
North Fair Haven, N.Y.....	Dec. 6, 1908	Mar. 26	Dec. 10, 1908	11.0	Apr. 6	There has been practically no ice in the lake during the winter; the steamer <i>Hinckley</i> was setting buoys on April 6; and the steamer <i>Cornelia</i> arrived from Kingston on April 10, 1909.
Oswego, N. Y.....	Dec. 7, 1908	Apr. 10	Dec. 6, 1908	8.0	Mar. 11	Black River and the harbor began breaking up on April 6, 1909.
Sacketts Harbor, N. Y.....	Dec. 20, 1908	.....	Jan. 2, 1909	9.0	Apr. 13	The gale of April 7 cleared the harbor of ice and the steamer <i>Pierrepont</i> arrived from Kingston on that date.
Cape Vincent, N. Y.....	Jan. 8, 1909	Apr. 7	Dec. 25, 1908	12.0	Apr. 13	The river free of ice below the light-house on March 2, but above it remained solid until late in March.
Ogdensburg, N. Y.....	Dec. 20, 1908	.....	Dec. 15, 1908	16.0	Mar. 30	.....

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. FITZHUGH TALMAN, Librarian.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a —

American aeronaut. New York. August, 1909.

Clayton, Henry Helm. The uses of sea breezes in balloon sport. p. 26-28.

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Ward, R. DeC. Effect of atmospheric pressure upon the earth's surface. p. 505-506. [Abstract of paper by Denison.]

Astronomical observatory of Harvard college. Annals. Cambridge. v. 56, pt. 3. 1908.

Clayton, H. Helm. The meteorology of total solar eclipses, including the eclipse of 1905. p. 192-216.

Rotch, A. Lawrence. The eclipse shadow bands. p. 217-222.

Astrophysical journal. Chicago. v. 30. July, 1909.

Humphreys, W. J. The radiation exponent of dry air. p. 20-25.

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Martin, Edward J. Some observations on dew-points. p. 174-195.

— The snow-line in Norway. p. 210. [Abstract of paper by Rekstad.]

— Climatic change in Egypt. p. 212. [Abstract of paper by Keelling.]

— The "Ornithias" of the Greeks. p. 218.

— Marsh vegetation and evaporation. p. 219. [Extract of paper by Yapp.]

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Ward, R. DeC. An outline of the economic climatology of Brazil. p. 13-22.

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